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R. J. Boyd

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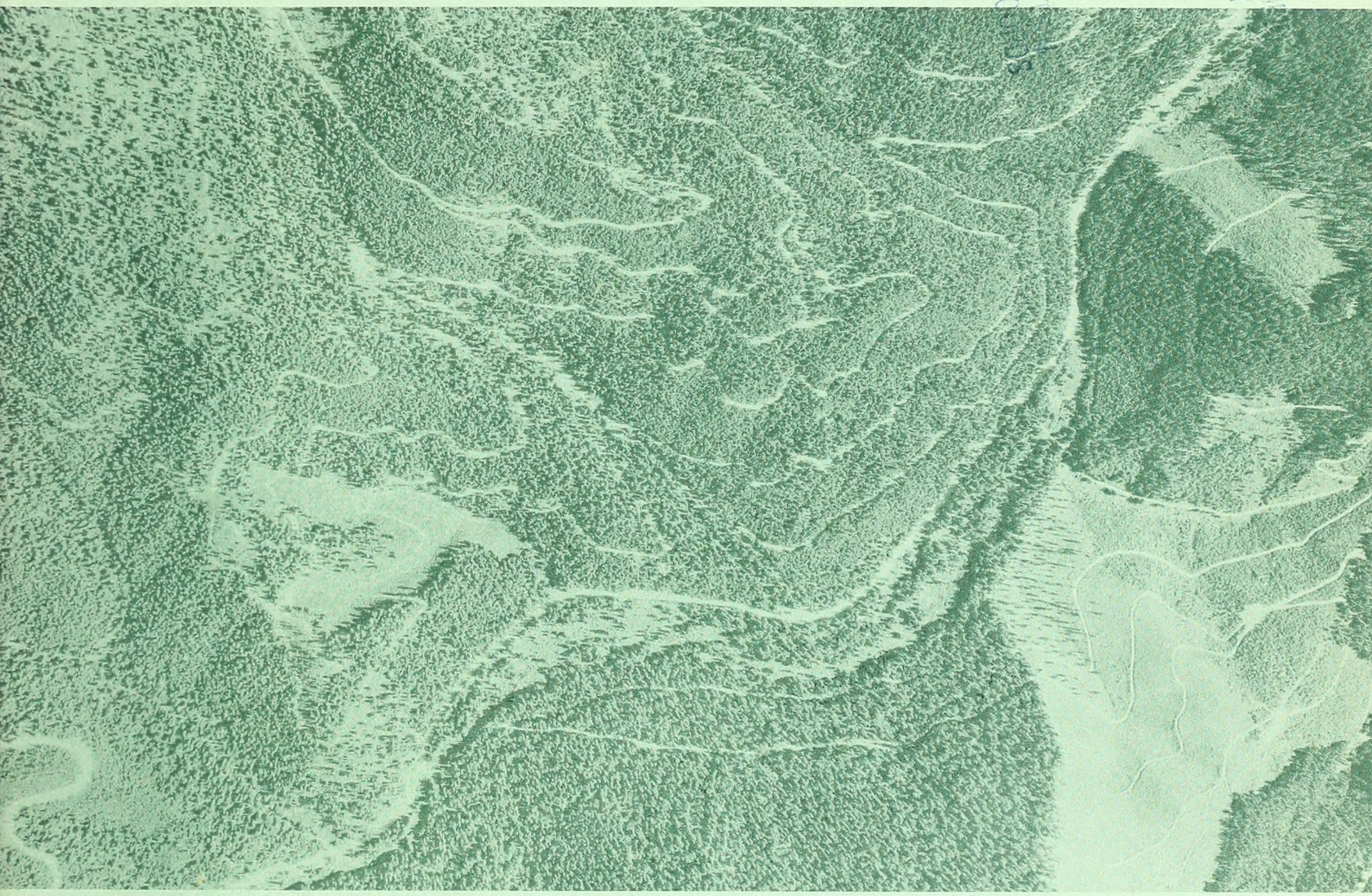

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INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
Ogden, Utah

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SOME CASE HISTORIES OF NATURAL REGENERATION IN THE WESTERN WHITE PINE TYPE

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INTRODUCTION

Natural regeneration of conifers in the "Western White Pine Type" is generally quite prompt on favorable sites under any of the even-aged silvicultural systems when an adequate seed source is reserved. Seedtree, shelterwood, and strip or block clearcutting have all met with considerable success (Haig et al. 1941). The coming of blister rust (Cronartium ribicola J. C. Fisch. ex Rabenh.) to the western white pine (Pinus monticola Dougl.) type made these methods less desirable and shifted the emphasis to clearcutting, prescribed broadcast burning, and planting. Under this system, Ribes (the currant genus and alternate host for blister rust) could be more economically eradicated and greater western white pine potentials established.

Recent developments have shown the futility of practical rust control by known Ribes eradication or chemical treatments (Ketcham, Wellner, and Evans 1968). Western white pine breeding programs should provide stock with an adequate degree of rust immunity for field planting in about 15 years. But until a chemical treatment which is applicable to seedling stands is developed, purposeful natural regeneration of white pine seems to be completely impractical except under those rare circumstances where Ribes are practically nonexistent or where climatic conditions limit the amount of pine infection.

The current emphasis in management of these forests, then, is on the regeneration of other suitable species common to the type. These may include grand fir (Abies grandis Lindl.), Douglas-fir (Pseudotsuga menziesii (Mirb.) Franc.), western hemlock (Tsuga heterophylla (Raf.) Sarg.), western redcedar (Thuja plicata D. Don.), western larch (Larix occidentalis Nutt.), ponderosa pine (Pinus ponderosa Laws.), lodgepole pine (Pinus contorta Dougl. var. murrayana (Grev. & Balf.) Engelm.), Engelmann spruce (Picea engelmannii Parry) and subalpine fir (Abies lasiocarpa (Hook.) Nutt.). These species constitute the major coniferous component of the ecological plant associations in which the Western White Pine cover type occurs. The principal "habitat types" include: Abies grandis/Pachistima myrsinites; Thuja plicata-Tsuga heterophylla/Pachistima myrsinites; Thuja plicata/Pachistima myrsinites; and Picea engelmannii-Abies lasiocarpa/Pachistima myrsinites (Daubenmire 1952).

While planting and seeding will be employed within these forest types when necessary or justifiable, reliance must be placed on natural regeneration for most of the reforestation job. But what natural regeneration can the timber manager expect in these types under various silvicultural systems? How fast will restocking occur? Can the composition and density of the new stand be controlled in the regeneration process, reducing the need for future silvicultural measures? Twenty years of natural reproduction records from stands on the Deception Creek Experimental Forest in northern Idaho provide some answers to these questions. The studies were established to supplement and give more definitive answers to some of the recommendations of Haig et al. (1941).[1] Although designed to feature western white pine in the future stand, they provide some valuable information on other species which should be useful in formulating alternative management guidelines.

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[1]Most of the studies reported were established by Kenneth P. Davis and Charles A. Wellner.

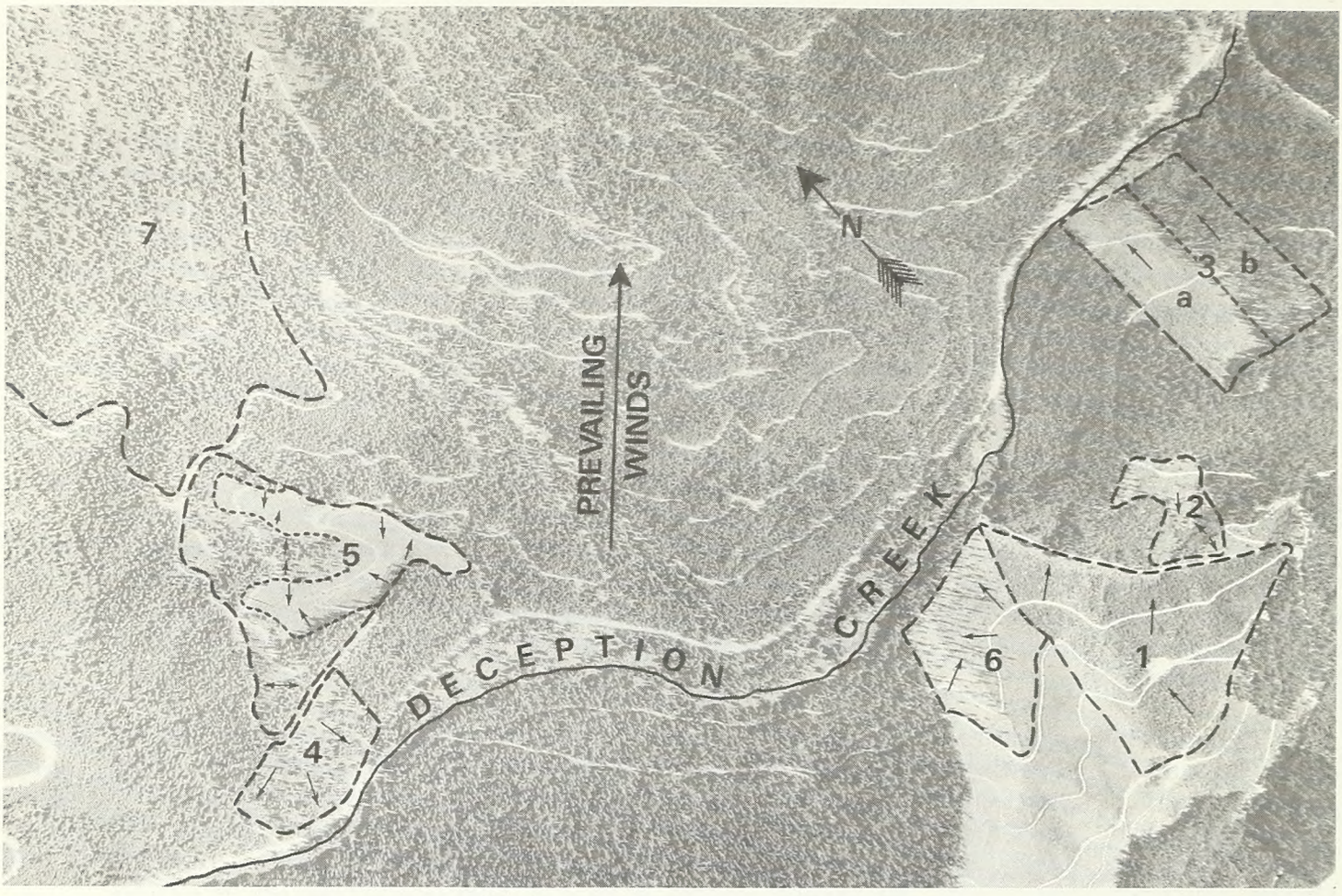

Figure 1.--1959 aerial view (approximate scale 1:15,000) of a portion of the Deception Creek Experimental Forest showing the location of regeneration studies described in this report. (Small arrows show aspect.)

Area 1.--Ames Creek: alternate shelterwood and clearcut strips.
Area 2.--Ames Creek seedtree block.
Area 3.--Tamarack Hill shelterwood block: a. low-value overwood felled; b. low-value overwood felled or girdled.
Area 4.--Haynes Creek shelterwood block.
Area 5.--Finger Gulch: alternate shelterwood and clearcut strips.
Area 6.--Synder Creek seedtree block.
Area 7.--Echo Peak selection cutting.

METHODS

The studies consist of five reproduction cuttings made between 1935 and 1937, and two that were made about 1951 (fig. 1). Treatments tested were strip clearcutting, shelterwood cutting, seedtree cutting, and selection cutting, each within the Abies grandis/Pachistima and Thuja-Tsuga/Pachistima habitat types, roughly equivalent, in the study area, to southerly and northerly aspects, respectively. Reproduction was inventoried on permanent transects at intervals ranging from 2 to 7 years after the initial regeneration cutting. Surveys generally consisted of an examination of species' occurrence on 4-milacre (1/250-acre) quadrats located along the transect lines, and a complete tally of seedlings on a 1-milacre (1/1000-acre) subsample of each 4-milacre unit. The percentage of 4-milacre units containing one or more trees (the "4-milacre stocking") provides an estimate of seedling distribution while the 1-milacre seedling

count gives an estimate of the total number of seedlings per acre. When considered together, these values characterize the distribution and density of the reproduction stand. Only "established" seedlings, 3 years old or older, were recorded.

A 4-milacre stocking of 65 percent has, for many years, been the criterion of adequate stocking in the western white pine type (Wellner 1940). This is the standard used in this report and is equivalent, in the average seedling stand, to about 1,000 trees per acre or to a 1-milacre stocking of 40 percent.[2]

INDIVIDUAL STUDY AREAS

Ames Creek: Alternate Shelterwood and Clearcut Strips

Description

Following the leads from examples of successful strip-clearcutting dating back to 1910, this 36-acre area on a northeasterly exposure in the Thuja-Tsuga/Pachistima habitat type was horse-logged in 1935. Two clearcut strips, 4 to 7 chains wide, alternated with three shelterwood strips 4 to 5 chains in width (fig. 2). Unmerchantable timber on the clearcut strips was felled in 1935 and 1936 following logging; slash on these strips was control-broadcast-burned in 1936.

The shelterwood cutting removed 60 percent of the 53,000 board feet per acre and left a stand averaging 31 trees per acre. Of these trees, about 27 were western white pine. This residual stand admitted 70 percent of full sunlight to the forest floor. Unmerchantable trees were felled and the slash progressively burned in the spring of 1936. By 1951 the area was adequately regenerated and the remainder of the shelterwood stand was "jammer" logged.[3]

Regeneration on this tract was influenced somewhat by a stand of mature timber that was on the western border of the upper portion. Undoubtedly, seed from this stand, which was not cut until 1952, was cast into the clearcut and shelterwood strips along with seed from the shelterwood residual.

Results

Shelterwood strips.--Regeneration within the shelterwood strips was very prompt and the distribution quite uniform (fig. 3). Four years after logging the 4-milacre stocking to all species was over 60 percent with 548 seedlings per acre. Eight years after logging the stocking had increased to 97 percent with 6,126 seedlings per acre.

Although the shelterwood stand contained no hemlock, this species was by far the most abundant in the reproduction. Some trees were advance growth, but the majority were seedlings originating from seed dispersed into the area from adjacent uncut stands. Western white pine was second in seedling representation with a 4-milacre stocking

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[2]Present regeneration examinations of the Northern Region of the Forest Service are based on 1/300-acre sample plots. By their standard a "minimum acceptable stand" would have at least 100 trees of crop-tree quality per acre, and a "desirable stand" would require at least 250 crop trees. Assuming only one crop tree per stocked plot and applying conversions developed by Lynch and Schumacher (1941), the "minimum acceptable stand" would be equivalent to 38 percent 4-milacre stocking or about 210 trees per acre. The "desirable stand" would be equivalent to a 4-milacre stocking of 85 percent or about 3,000 trees per acre.

[3]"Jammer" logging is a portable cable system utilizing a mobile boom 25-30 feet long. Maximum skidding distances are 400 to 600 feet. The system is operated with or without a haul-back line.

Figure 2.--Ames Creek alternate shelterwood and clearcut strips 3 years after logging.

of 70 percent 8 years after logging. Grand fir was the third most abundant species, followed by western larch and Douglas-fir. Redcedar and spruce appeared as minor components on limited portions of the area.

There was no stocking survey immediately after removal of the shelterwood residual in 1951; therefore, the logging damage to reproduction already established could not be estimated. Four years after logging, however, these losses had been more than replaced by new germinants and by seedlings that were less than 3 years old in 1950.

With the exception of hemlock and larch, there was a continued increase in number of trees per acre throughout the 20-year period, but generally at a lesser rate after the initial 8 years. While the greatest increase in number of established grand fir seedlings occurred during the final 5 years of the 20-year period, this caused virtually no increase in stocking.

Clearcut strips.--Though quite adequate, regeneration on the clearcut strips has not been as prompt nor as complete as on the intervening shelterwood strips (fig. 4). A good seed year preceded logging on this area, and the broadcast burning of slash on the clearcuts apparently destroyed or reduced the reproduction from the prelogging seed supply. Four years after cutting, all-species' stocking was 15 percent as compared to 61 percent under shelterwood. From the eighth year on, stocking on the clearcut and shelterwood areas was nearly the same.

Seedling-abundance rankings for the species were essentially the same on the clearcut as on the shelterwood strips, but the number of seedlings and stocking percent for all species except western hemlock were generally reduced. Grand fir reproduction was only about one-fourth as abundant on the clearcut areas. Larch and Douglas-fir stocking and seedlings per acre were also less than under the shelterwood.

Hemlock, at the end of 20 years, constituted nearly 90 percent of the stand on the clearcut area. However, the more intolerant species on the clearcut area were in a somewhat better competitive position than on the shelterwood area. Overwood shade had for many years favored the growth of tolerant species in the shelterwood areas.

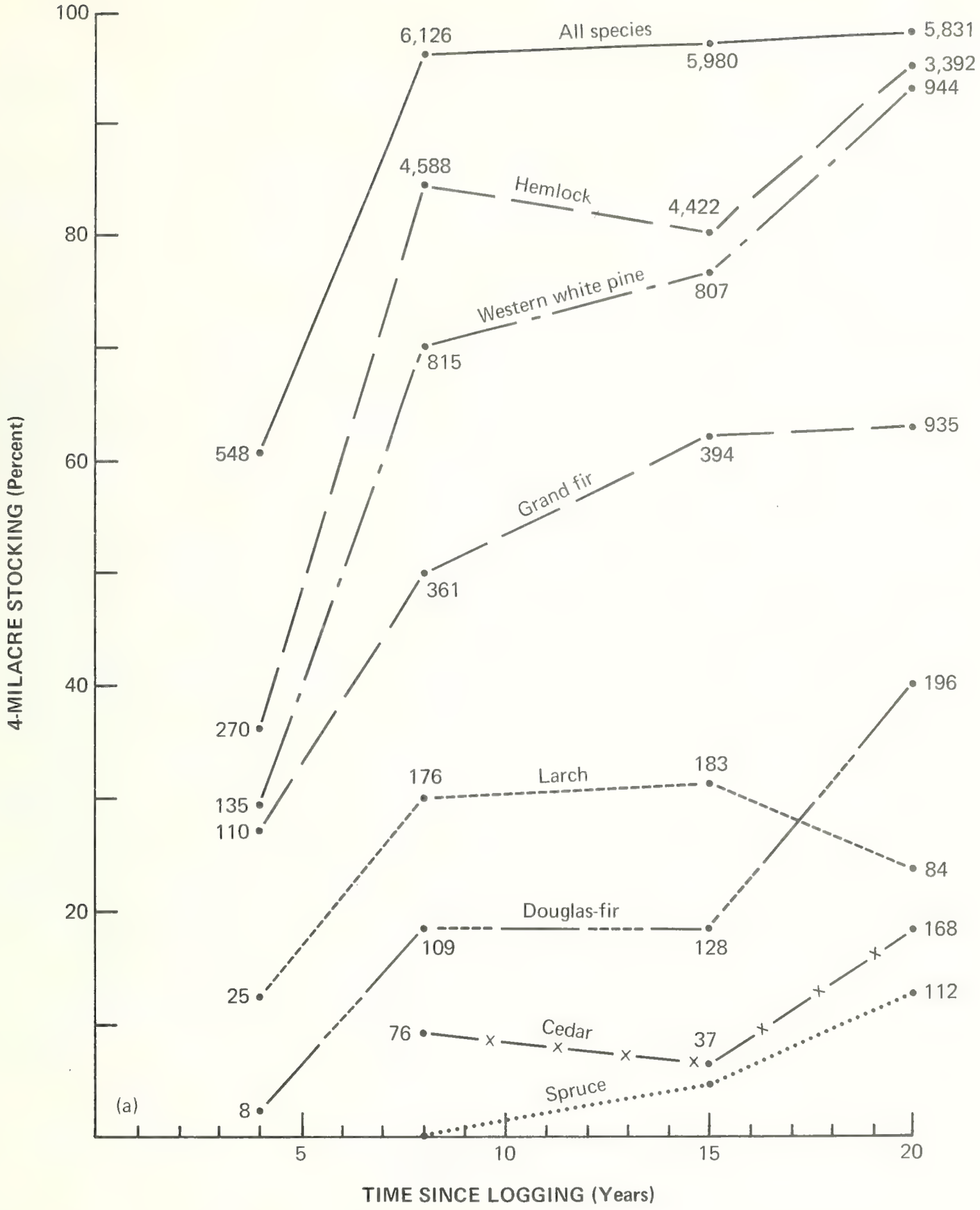

Figure 3.--Regeneration trends for shelterwood strips in the Ames Creek Alternate. Numbers on the points of the curves designate numbers of seedlings per acre.

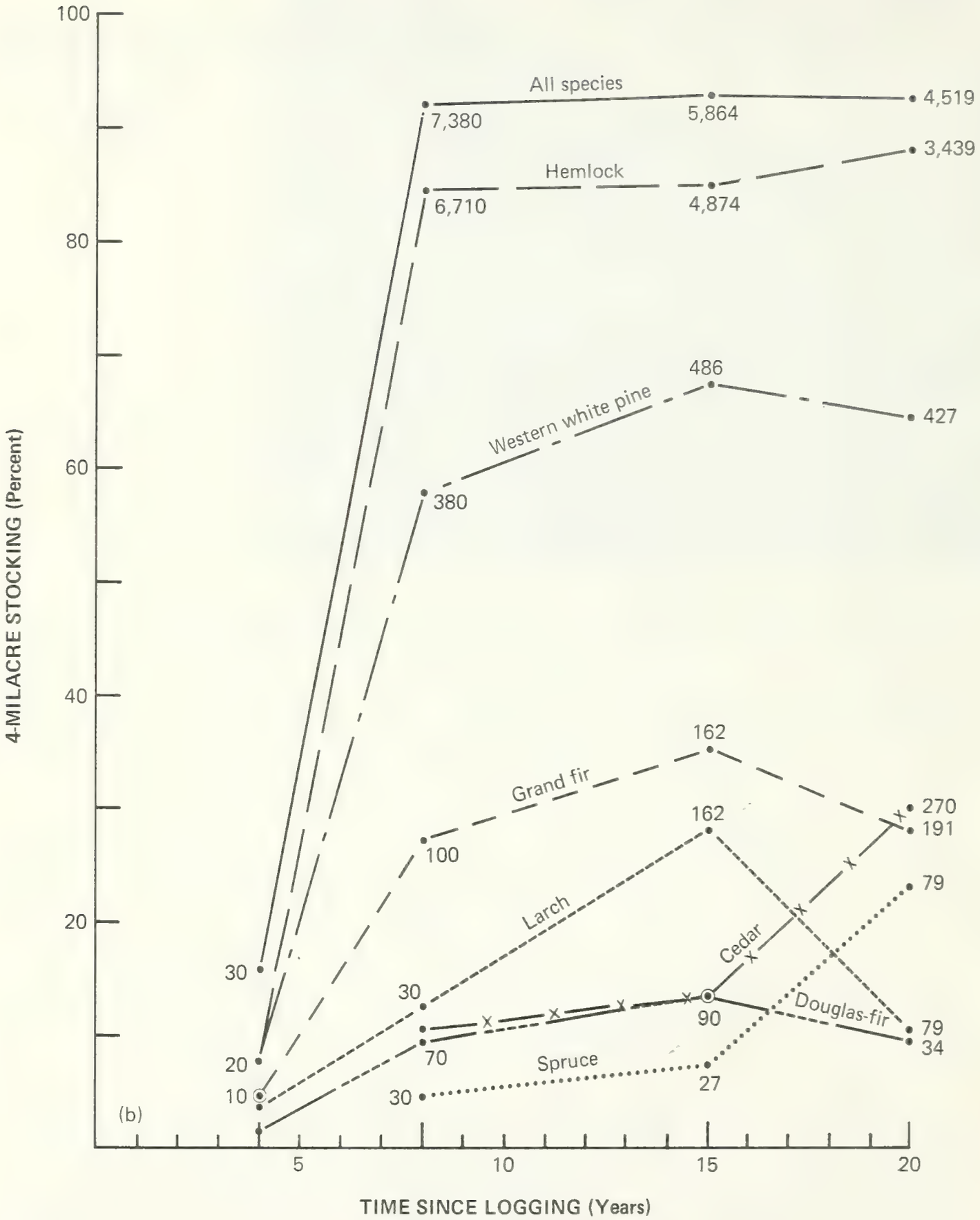

Figure 4.--Regeneration trends for clearcut strips in the Ames Creek Alternate. Numbers on the points of the curves designate numbers of seedlings per acre.

Ames Creek: Seedtree Block

Description

This area was originally horse-logged as a shelterwood in 1935, then accidentally burned over in the fall of 1936. The subsequent salvage of fire-killed trees left a seed-tree stand of four to six western white pine trees per acre. The area is 11.5 acres in size, and the exposure is generally southwesterly (Abies grandis/Pachistima habitat type) with some northwesterly (Thuja-Tsuga/Pachistima habitat type) aspects. Mature stands border the upper edge of the area on the north and east.

Results

The Ames Creek area regenerated rather slowly for the first 15 years after logging (fig. 5). At the end of this period, 60 percent of the area was stocked with "any-species." From 1950 to 1955, stocking increased to 96 percent and the number of seedlings per acre increased by threefold. Grand fir, the most abundant species in the adjacent stands, comprised 60 percent of the stand 20 years after logging. Hemlock and white pine seedlings were second and third in abundance. A small component of redcedar, Douglas-fir and larch completed the stand.

The rapid increase in regeneration establishment from 1950 to 1955 probably resulted from favorable summer weather in 1948. Precipitation that year was well above normal for July, and temperatures averaged 2 to 3 degrees below normal for July and August. Seedlings which germinated during this favorable year were probably not recorded in 1950 as "established" seedlings.

Hemlock and redcedar reproduction was restricted to the northwesterly aspect of a spur ridge which extends through the area. The predominant southwesterly slopes became covered by a dense growth of Ceanothus; under this competition, western white pine seedlings were spindly and of poor vigor compared to the grand fir.

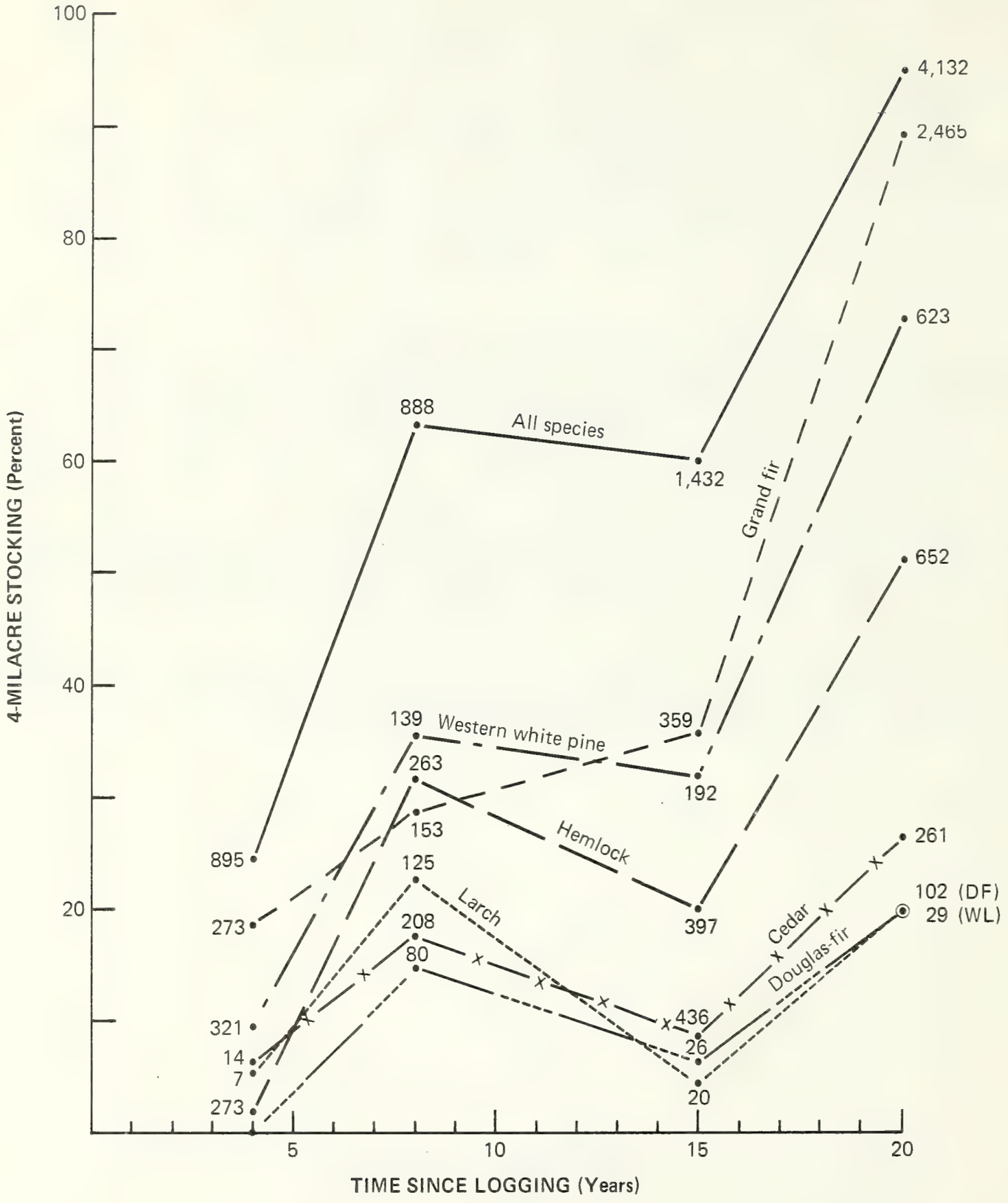

Figure 5.--Regeneration trends in the Ames Creek seedtree block. Numbers on the points of the curves designate numbers of seedlings per acre.

Figure 6.--Heavy shading by the Tamarack Hill shelterwood stand favored growth of western hemlock and suppression of less tolerant species.

Tamarack Hill: Shelterwood Block

Description

This 27-acre tract is located on a steep north slope. The entire area is Thuja-Tsuga/Pachistima habitat type. In 1935 and 1936, two overstory treatments were applied, both of which resulted in nearly pure western white pine shelterwood stands. One half of the tract (area 3a in fig. 1) contains hemlock and grand fir trees that were all highly defective or otherwise unmerchantable; these were felled and the slash was piled and burned. On the other half (area 3B), fir and hemlock larger than 8 inches d.b.h. were girdled, smaller stems were felled, and the slash was piled and burned. The reserve stand permitted only an estimated 50 percent of full sunlight (fig. 6), beneath the canopy on the area where all of the low-value stems were felled. Under the canopy where girdling had been done, the light probably was even less for several years, but it approached the same intensity after the girdled trees died and began to deteriorate.

Results

Four years after logging, stocking of the combined species on this area was above 80 percent, and by the eighth year stocking exceeded 90 percent (figs. 7, 8) with 13,000 seedlings per acre. Regeneration was most rapid on the portion of the area where all of the low-value trees were felled, but it seems likely that this was due more to a favorable location with respect to adjoining seed sources and the prevailing wind than to the nature of the treatment of unmerchantable overstory.

At the end of the period of record, hemlock and grand fir, though virtually eliminated from the shelterwood stand, far outnumbered western white pine in the regeneration.

The disturbance caused by logging the residual overstory on half of the area in 1952 reduced stocking of all-species from 100 percent to 86 percent. Losses were greatest among the western white pine, grand fir, and larch reproduction.

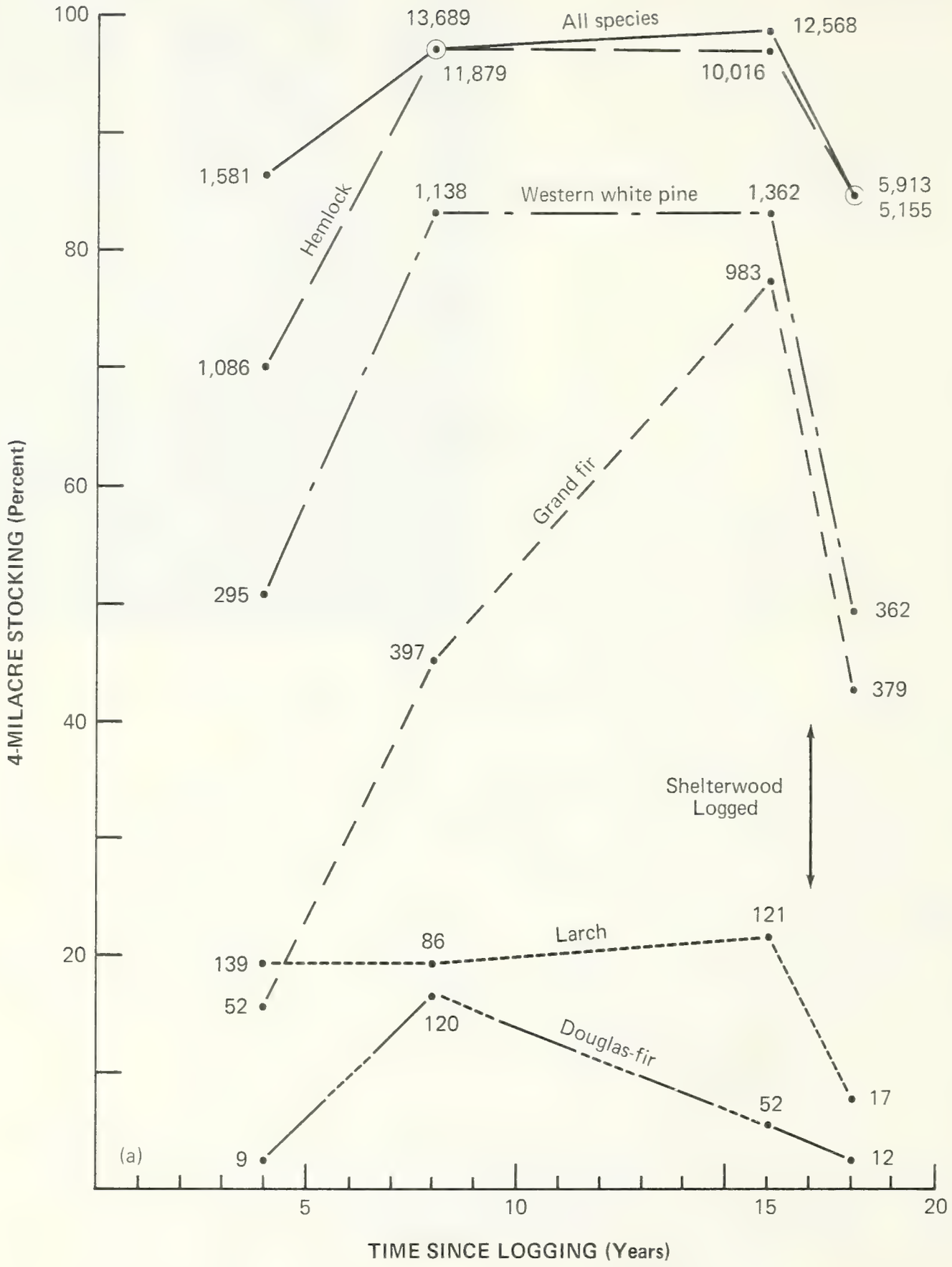

Figure 7.--Regeneration trends on the Tamarack Hill shelterwood blocks--cull trees felled after logging and residual western white pine removed in 1952. Numbers on the points of curves designate numbers of seedlings per acre.

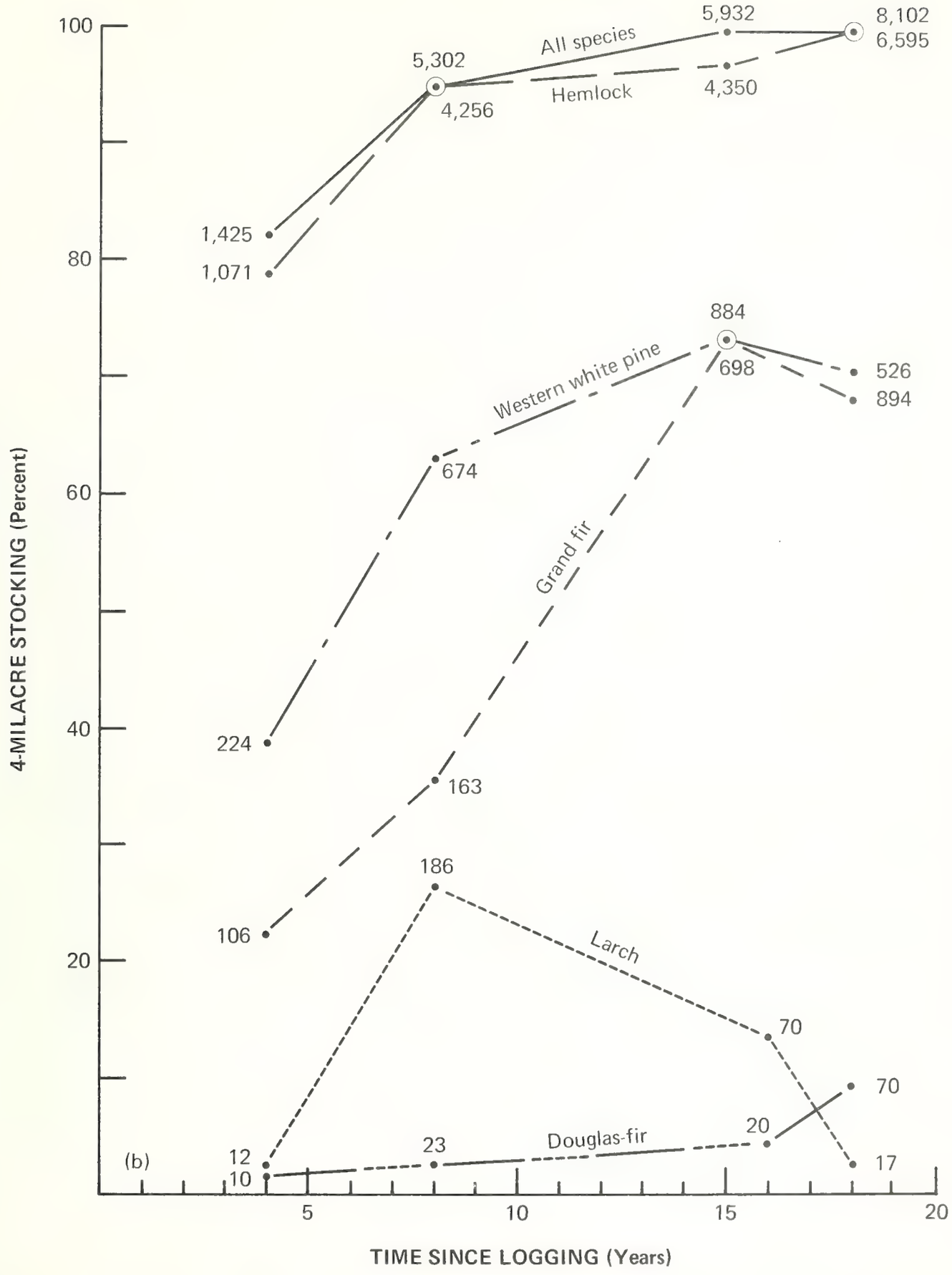

Figure 8.--Regeneration trends on the Tamarack Hill shelterwood blocks--cull trees girdled and residual western white pine not removed. Numbers on the points of curves designate numbers of seedlings per acre.

Haynes Creek: Shelterwood Block

Description

Horse-logging on this 15-acre block in 1936 removed most of the associated species, leaving a nearly pure western white pine shelterwood. Slash was piled and burned in 1936 and 1937. The light intensity in this shelterwood was probably less than 50 percent. The establishment report states that the canopy was denser than in either of the previously mentioned shelterwood stands. The area lies on a very steep lower slope with south- to west-facing aspects. Mature stands border the area on all sides. The survey transects were located so as to sample reproduction separately on the westerly (*Thuja-Tsuga/Pachistima* habitat type), southwesterly, and southerly (both *Abies grandis/Pachistima* habitat type) exposures (figs. 9, 10, 11).

Results

Regeneration of the Haynes Creek shelterwood block has been slow. Stocking of all species combined reached a satisfactory level within 10 to 15 years on the more favorable westerly aspect and within 19 years on the more severe southerly exposure; however, stocking was not yet adequate after 19 years on the very unfavorable southwest exposure (fig. 10). Individual-species regeneration followed a similar pattern. Both grand fir and Douglas-fir were generally more abundant and had better stocking than western white pine, although seed for these species had to come primarily from adjacent stands. Hemlock reproduction was restricted to the moist lower slopes.

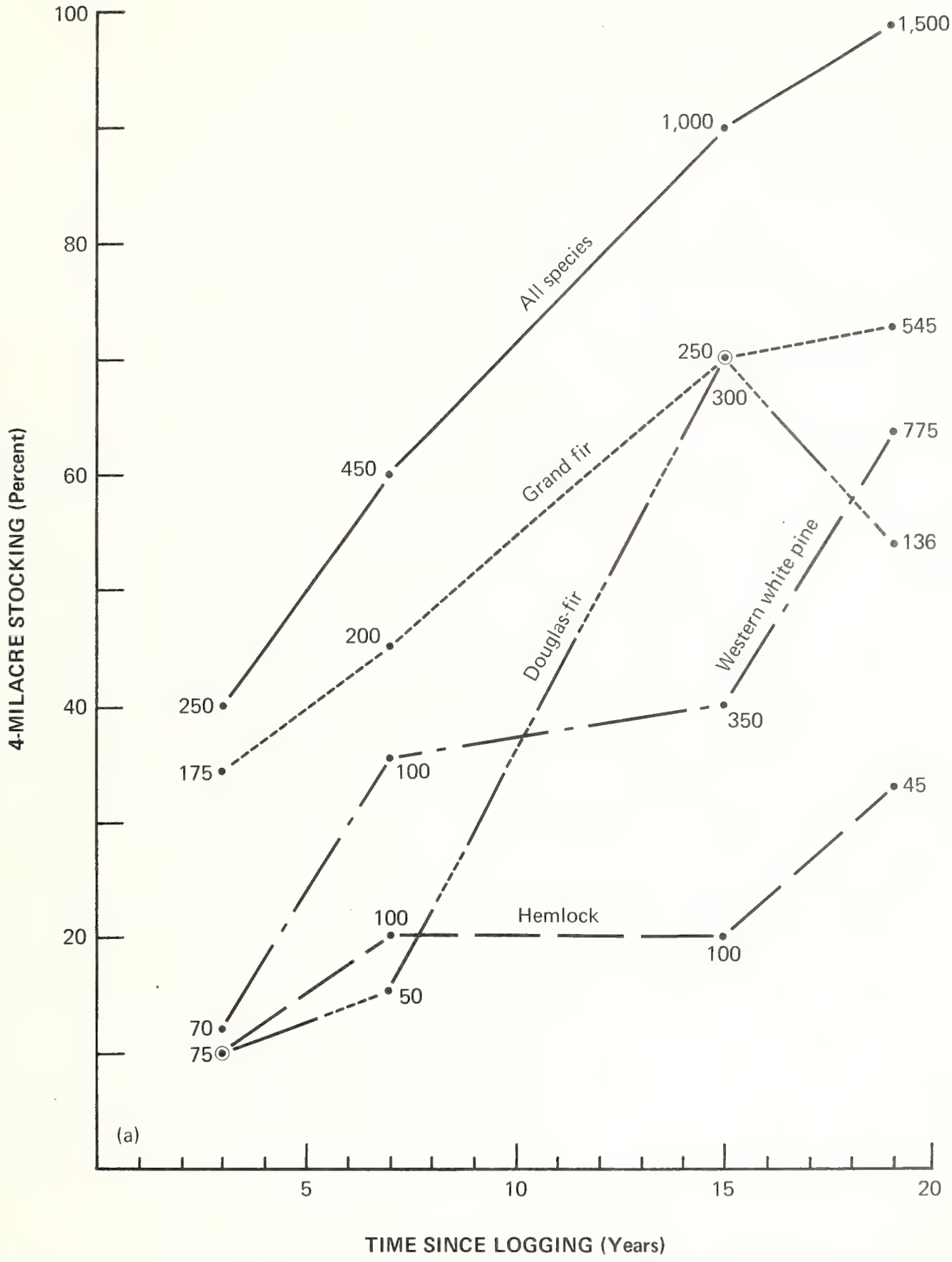

Figure 9.--Regeneration trends on the Haynes Creek shelterwood block (westerly aspect). Numbers on the points of the curves designate numbers of seedlings per acre.

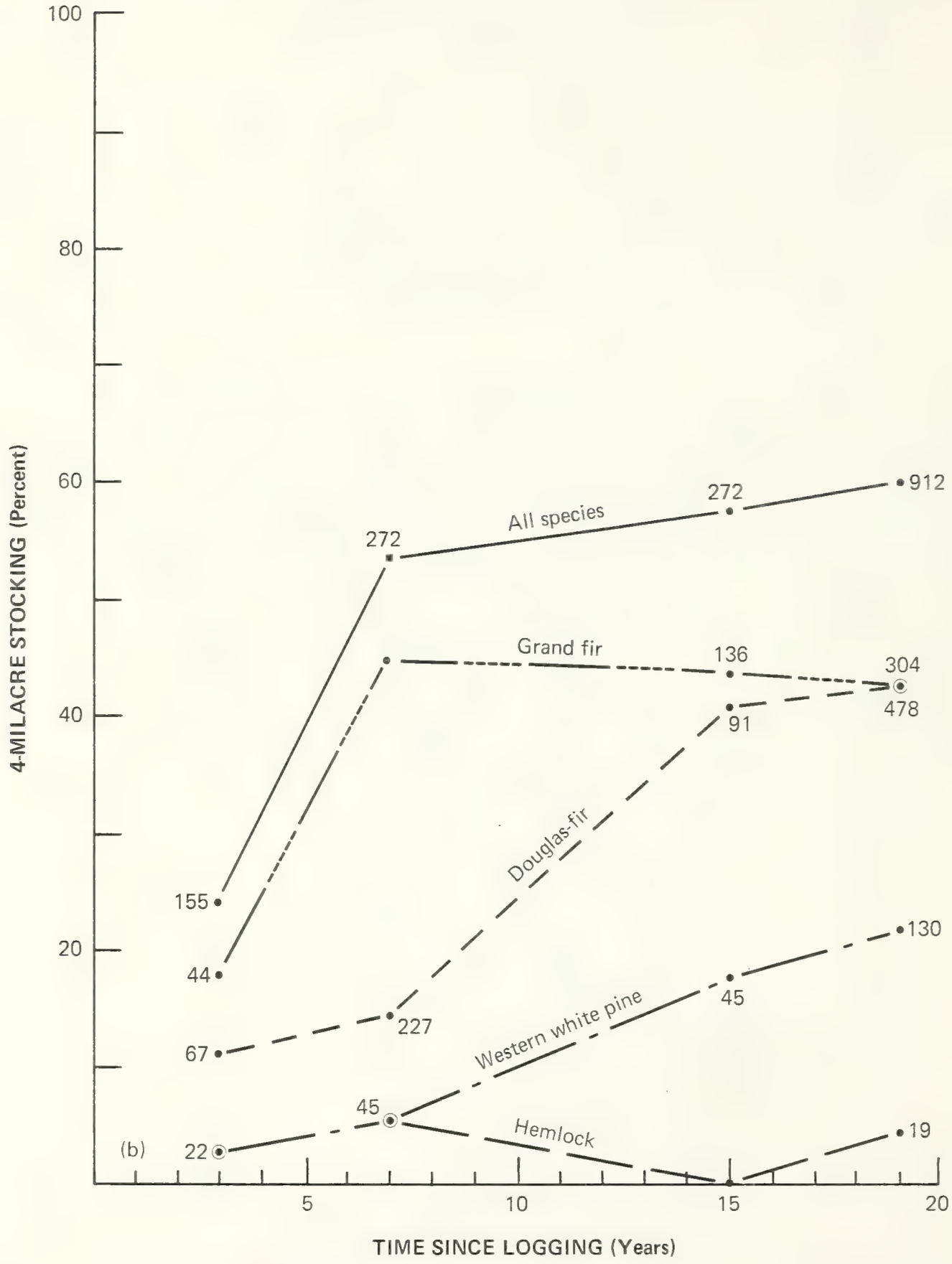

Figure 10.--Regeneration trends on the Haynes Creek shelterwood block (southwest aspect). Numbers on the points of the curves designate numbers of seedlings per acre.

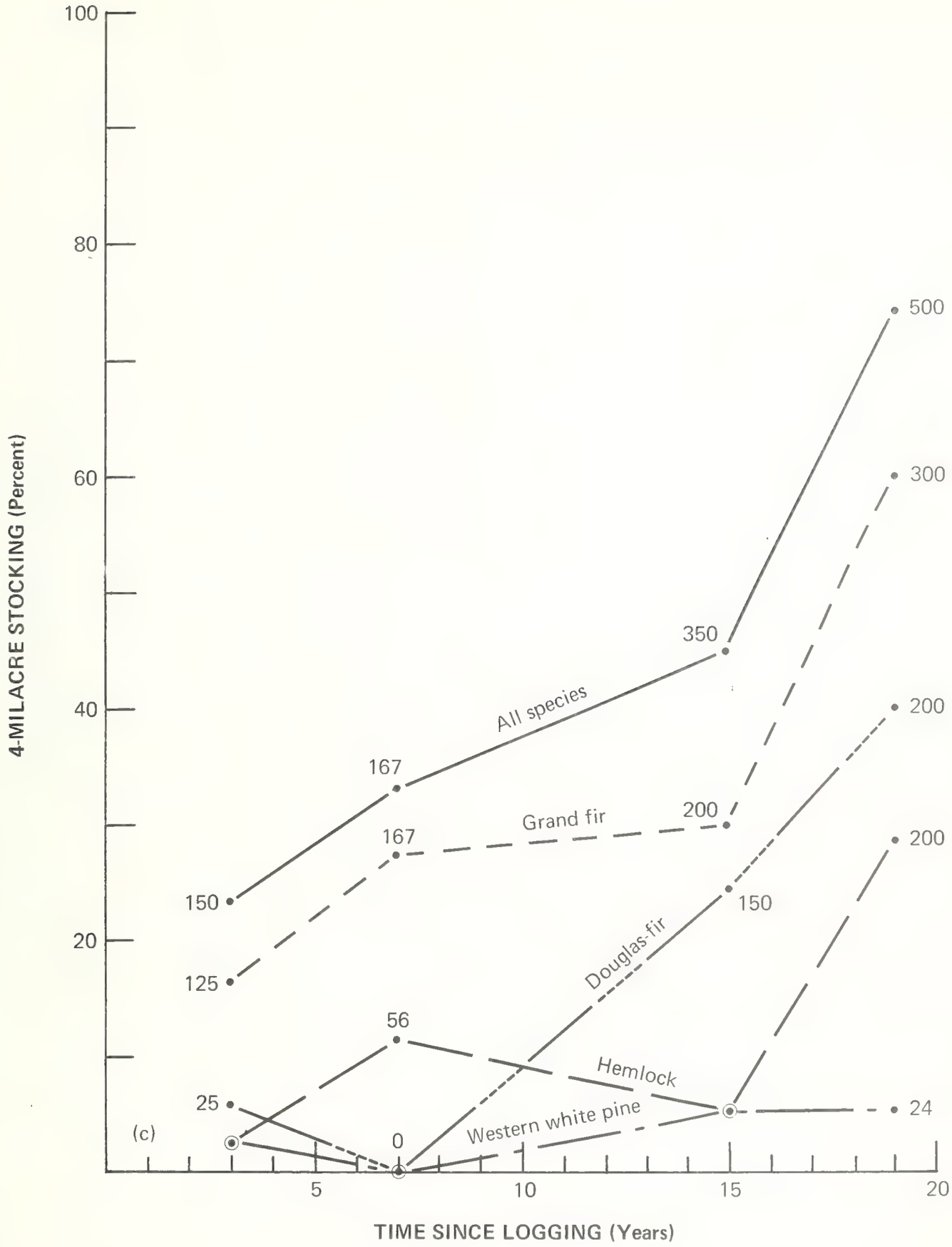

Figure 11.--Regeneration trends on the Haynes Creek shelterwood block (southerly aspect). Numbers on the points of the curves designate numbers of seedlings per acre.

Finger Gulch: Shelterwood-Strip-Clearcutting

Description

This area contains two clearcut strips, 4 to 9 chains wide, and adjacent shelterwood cuttings. The clearcut portions total 17 acres and straddle the main stream and a tributary while 21 acres of shelterwood occupy the upper slopes and ridgetops. Ecologically, the area is a mosaic of Thuja-Tsuga/Pachistima and Abies grandis/Pachistima habitat types with northeasterly-through-southerly-to-southwesterly aspects. The timber was horse-logged in 1937. Slash on the clearcut strips was broadcast-burned in 1938 and 1939. The shelterwood cutting left 50 percent of the western white pine volume and an average of 15 trees per acre exceeding 14 inches d.b.h. The defective residual trees in the shelterwood were slashed, piled, and burned.

Results

Stocking of all species combined on the shelterwood portion of the Finger Gulch area was over 80 percent at the time of the first survey, 14 years after logging (fig. 12). It seems likely that stocking reached an adequate level prior to the tenth year. Grand fir occupies the most prominent position, followed by hemlock and western white pine.

On the clearcut strips, 13 years passed before the all-species' stocking level was adequate (fig. 13). As on the shelterwood area, grand fir was the best distributed species, but hemlock was superior numerically because of its high density in small areas where topography and moisture favored its establishment.

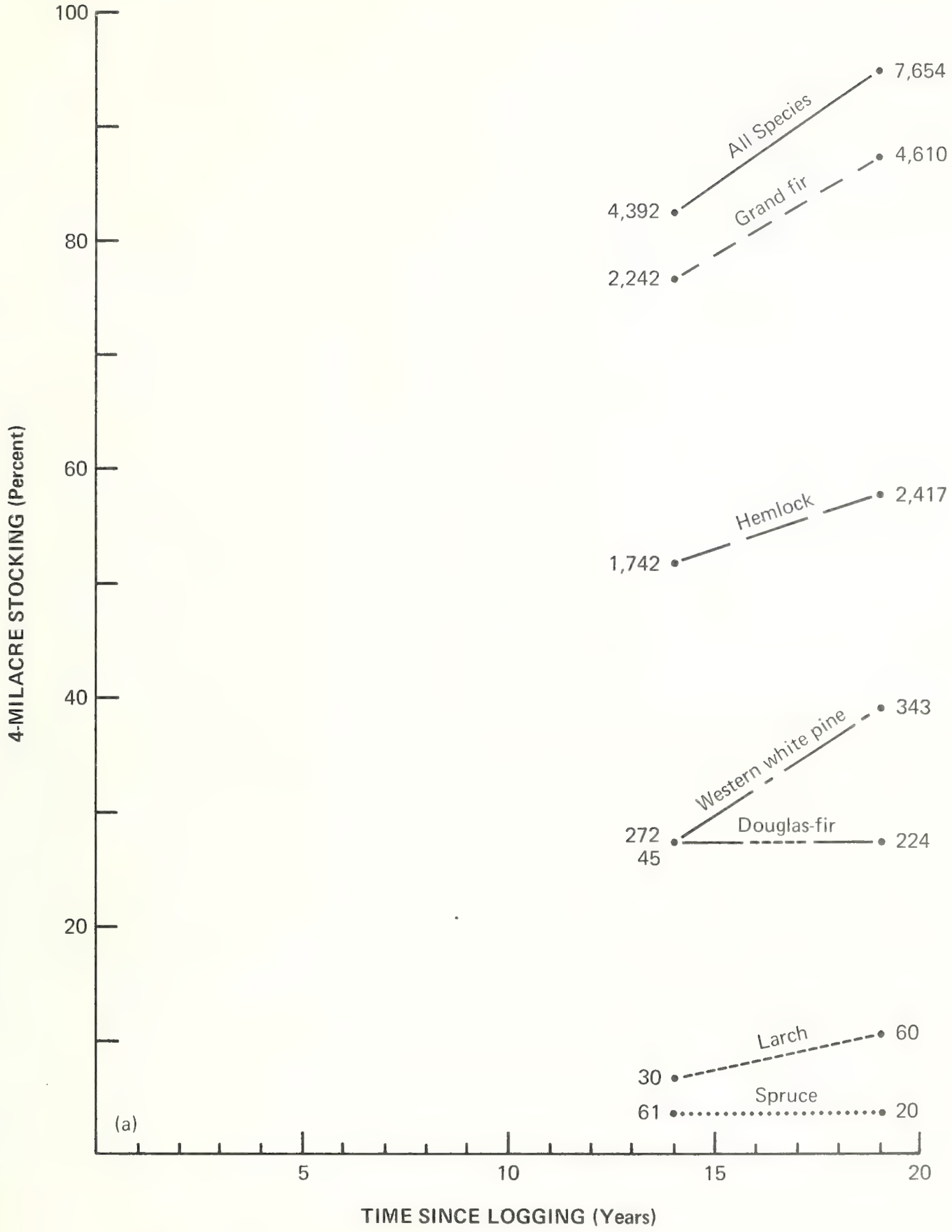

Figure 12.--Regeneration trends in shelterwood strips in Finger Gulch. Numbers on the points of the curves designate numbers of seedlings per acre.

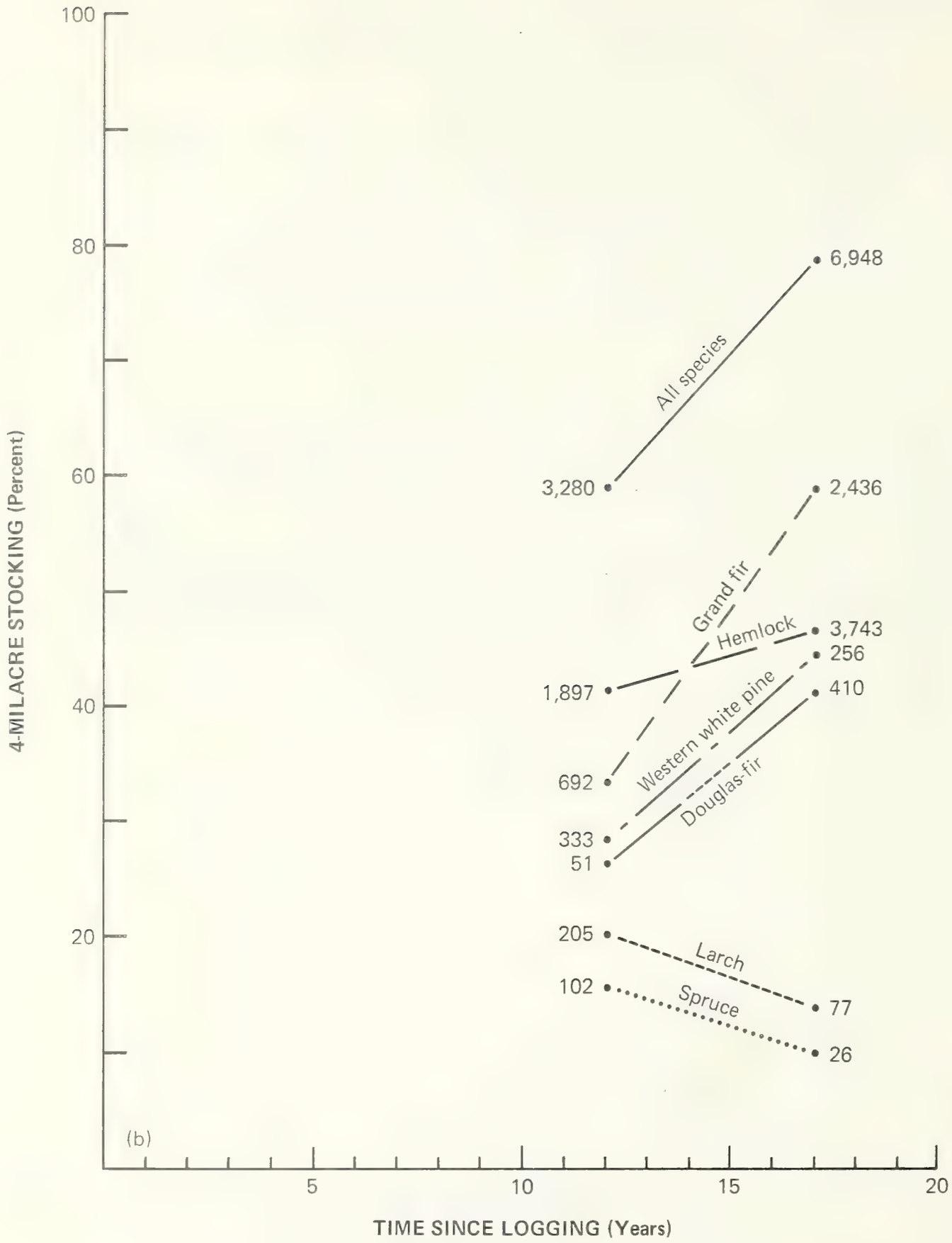

Figure 13.--Regeneration trends in clearcut strips in Finger Gulch. Numbers on the points of the curves designate numbers of seedlings per acre.

Figure 14.--Regeneration entered promptly under the western white pine seedtree stand on this lower north slope in Snyder Creek.

Snyder Creek: Seedtree Cutting

Description

This 11-acre, north-slope tract was jammer-logged in 1952 leaving about nine western white pine seed trees per acre and some unmerchantable hemlock and grand fir. Slash from the logging was piled and burned in 1953. The unmerchantable trees were felled in 1954 and the slash from these was also piled and burned. Mature timber bordered this area on the north and west (fig. 14).

Results

Annual observations during the post-logging years showed that this area regenerated rapidly to a variety of species with hemlock and western white pine the most abundant. Most of the early western white pine reproduction was infected with blister rust. By 1956 Ribes eradication had reduced the infection source enough to permit good establishment of relatively rust-free pine (fig. 15), but other species had gained in dominance. For instance, reproduction measurements during 1959 showed that while 88 percent of the area was stocked with western white pine, other species were dominant on 68 percent of the plots.

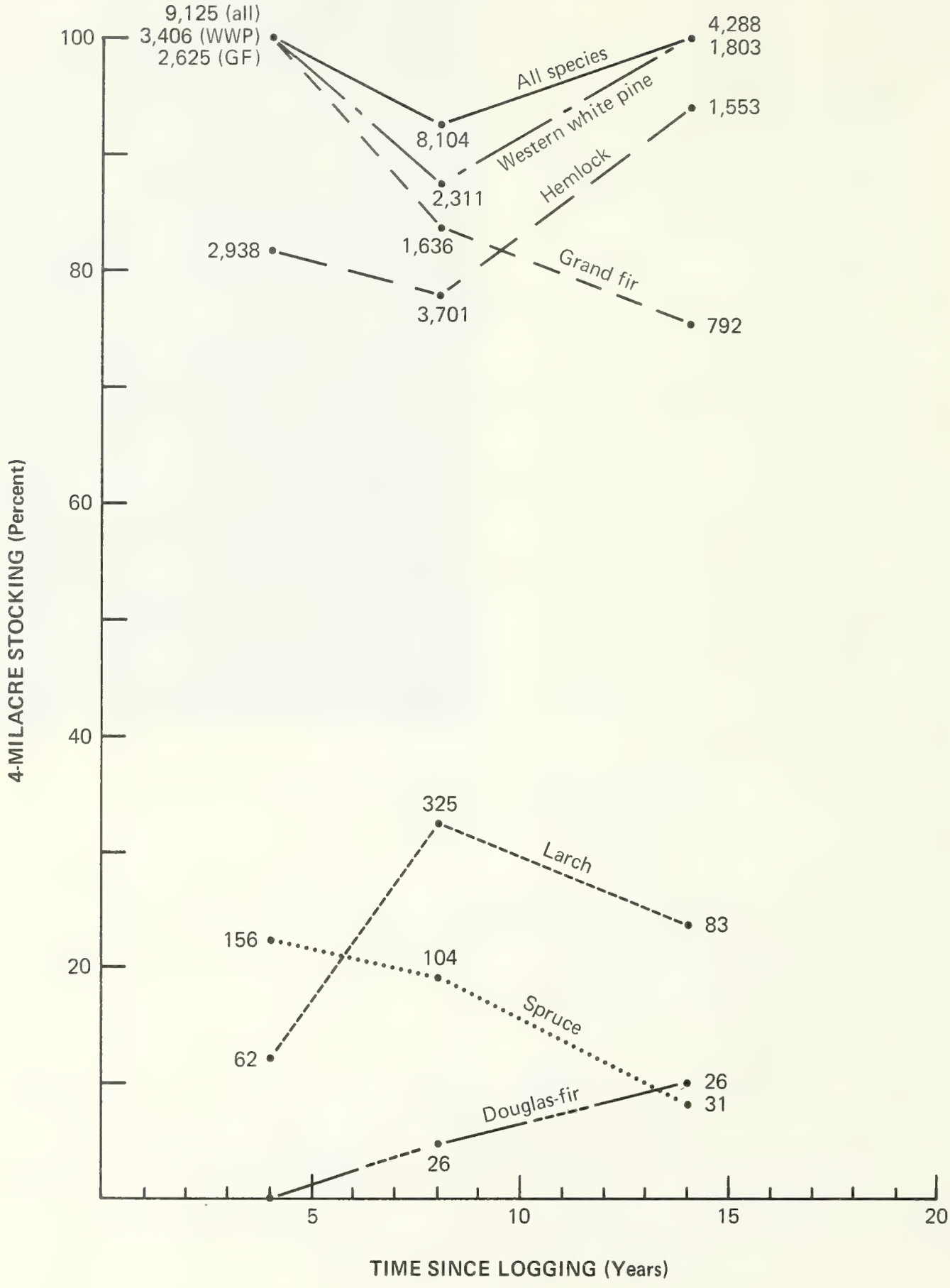

Figure 15.--Regeneration trends on the Snyder Creek seedtree block. Numbers on the points of the curves designate numbers of seedlings per acre.

Echo Peak: Selection Cuttings

Description and Methods

This study was established on a 700-acre tract of uneven-aged timber to test the effects of repeated light cuttings on regeneration and on the growth of the remaining stand. Cuttings of this type have been proposed, and used to a limited extent, as the best way to manage the drier and warmer south-facing slopes within the "western white pine type." Gradual harvest, permitting a gradual entry of reproduction, helps to protect the characteristically thin soils from serious losses which might result from more drastic conversion methods.

The Echo Peak area is situated on rather dry upper slopes, with east, south, and west aspects represented. Portions of the stand were partially logged in 1939-41 and the entire area was again selectively logged in 1950-51 to remove dead, defective, and poor-vigor trees. In 1952 ten randomly located strips, each containing five circular 1/5-acre plots, were established. On these plots, trees larger than 6 inches d.b.h. were tagged for growth measurements and counts were made of all smaller trees by 1-inch diameter classes. Trees less than 3 years old were not recorded. In 1957 a smaller reproduction sample was taken within five 1/20-acre plots that were concentric with the five original 1/5-acre plots. About one-third of the study plots were in areas classified as Thuja-Tsuga/Pachistima and the remainder were on Abies grandis/Pachistima sites. Composition of the "seed-producing" overwood (trees 10 inches d.b.h. or larger) in 1952 was 44 percent grand fir, 26 percent Douglas-fir, 26 percent western white pine, 2 percent larch, and 2 percent hemlock. The former harvest cuttings and natural mortality had removed approximately 50 percent of the merchantable volume.

Results

Until 1952 the cuttings in the Echo Peak tract had not resulted in any appreciable regeneration. At that time, the stand 1-inch d.b.h. and under averaged only 46 trees per acre. By 1957, reproduction was considerably more abundant with an average of 338 trees per acre that were less than 0.6 inch in diameter. Western white pine and Douglas-fir reproduction increased during the 5-year period but not nearly as rapidly as grand fir.

Regeneration on plots classified as Thuja-Tsuga/Pachistima habitat type had an average of over 400 seedlings per acre in 1957. Plots within areas of the Abies grandis/Pachistima habitat type had an average of under 300 seedlings per acre. Species composition on these two habitat types was similar. More than 75 percent of the seedlings were grand fir on each habitat type. Of the 18 plots in the Thuja-Tsuga/Pachistima habitat type, none were without seedlings whereas four of the 32 plots in the Abies grandis/Pachistima habitat type had no seedlings.

DISCUSSION AND CONCLUSIONS

The results of these studies confirm much of what has already been reported concerning the natural regeneration of western white pine (Haig et al. 1941). Also, these results provide additional information concerning the regenerative behavior of other species and help to refine our knowledge of the variables associated with natural regeneration in two of the major habitat types of Northern Rocky Mountain forests.

Thuja-Tsuga/Pachistima Habitat Type

On favorable aspects, represented at Deception Creek by the Thuja-Tsuga/Pachistima habitat type, the forester can use any of the even-aged silvicultural systems and be quite sure of adequate diverse natural regeneration within 5 to 10 years after the regeneration cut. Western hemlock is apt to be the most abundant species in the new stand if a seed source is left nearby. Hemlock regeneration was generally as abundant

in clearcut areas as it was under shelterwood stands. Where the shelterwood stand was not removed early in the regeneration process, hemlock reproduction now almost completely dominates the new stand. On clearcuts or shelterwood regenerated stands where the overwood was removed promptly after regeneration was obtained, the full-sunlight environment has generally resulted in reproduction with a greater variety of species in the potential crop-tree stand.

Natural regeneration of grand fir on these moist sites seems to have been best under a shelterwood stand, but was suppressed by hemlock when the shelterwood was retained too long.

Western white pine regeneration has been prompt and adequate, but protection from blister rust has been a continuous and costly job. Like grand fir, but to a greater extent, western white pine was dominated by hemlock reproduction under the prolonged shade of shelterwood stands.

Although western larch is of minor numerical importance in the reproduction stands on these areas, it usually becomes dominant on any quadrat on which it occurs, due to its rapid early growth. A rather curious decline in the stocking percentage of larch appears to have occurred, even under clearcut conditions, after an initial period of continuous build-up.

Douglas-fir was a minor component of the reproduction stand on all study areas of the Thuja-Tsuga/Pachistima habitat type. In older, unmanaged stands of this habitat type, Douglas-fir is nearly always a minor and short-lived stand component. Until its performance in stands characterized as Thuja-Tsuga/Pachistima habitat type has been proven, it should probably not be relied upon as an important element of the crop-tree stands.

Abies grandis/Pachistima Habitat Type

Dry sites, represented at the Deception Creek Experimental Forest by the Abies grandis/Pachistima habitat type, are characterized by a prolonged forest regeneration period which may exceed 20 years. With such long regenerative periods, additional time and growth will be lost through subsequent years of severe competition from other vegetation, mainly shrubs.

None of the species restocked these areas as rapidly as they did those areas of the Thuja-Tsuga/Pachistima habitat type, and their importance differed considerably. Grand fir was the most abundant species in the new stands, followed closely by western white pine and Douglas-fir. Under selection cuttings, grand fir promises to dominate future stands to the almost complete exclusion of other, less shade-tolerant species. Clearcut and shelterwood conditions have resulted in regeneration of the greatest variety of species.

Douglas-fir has a much more important role in these south-slope reproduction stands than on the moist sites. It is more abundant under these south-slope conditions and it maintains better vigor through to maturity.

Some important factors that determine what regeneration prescription is best for a given area include:

1. Species desired in the future stand. With the demonstrated uncertainty of the comparative economic values as well as unforeseen species' susceptibility to certain disease or insect epidemics, it would seem that "mixtures" should usually be favored in regeneration planning--conditioned by the use of available and pertinent information on suitability of species to the site and to each other.

2. Nature of the parent stand. Natural regeneration measures should not be attempted in overmature stands where there is an inadequate seed source of desirable species. Furthermore, natural regeneration should not be the sole measure where the seed source consists of only one species on a site that is capable of supporting a more diverse stand. Careful consideration should also be given to the composition of the adjacent stands in relation to the size of the area to be regenerated and the probable abundance and dissemination of the seed of various species.

3. Other-use considerations. Maintenance of a timber cover for soil or downstream watershed protection may be a prime consideration. Forests can be regenerated under these limitations by selection cutting, but species' diversity may have to be sacrificed. On south slopes, where this is most apt to be a problem, such cuttings will hasten the production of a climax forest of grand fir. Another consideration might be the need to provide a better winter range for big game. Maintenance of present big game herds depends upon the preservation of shrub cover on much of the lower south slopes characterized as Abies grandis/Pachistima habitat type. This need could reduce, or even eliminate, the need for tree regeneration on these areas.

4. Topography and slash disposal. Slash disposal in a residual seed-tree or shelterwood stand located on steep slopes requires costly piling and burning. Prescribed burning of clearcut blocks or strips seems to be the only practical alternative at present. On gentle slopes or level ground, machine methods of slash disposal and other site preparation become economically possible and this provides wider choice of silvicultural techniques.

5. Advance growth. New reproduction may receive severe competition from brush and older understory trees at the outset. Abundance and condition of this advance growth, together with the anticipated logging mortality and injury, should be considered in deciding whether to feature it in the next crop or not. Most of this is apt to be hemlock, grand fir, and redcedar. The hemlock and grand fir are often badly infected with brown stringy rot (Echinodontium tinctorium Ell. & Ev.). Furthermore, a marked increase in root-rot infection (Armillaria mellea (Vahl. ex Fr.) Quel.), with accompanying decline in vigor, has been observed after the abrupt release and thinning of western redcedar (Koenigs 1969).

While prompt regeneration is desirable, a gradual entry of natural regeneration may have certain advantages. In the first place it may provide for a greater diversity of species in the new stand. Species seldom seed equally well in any given year, so a sequence of years could provide a greater number of species and more varied management opportunities in the future. A gradual stocking build-up also provides for better initial stocking control through periodic checks that give the manager an opportunity to remove the seed source in time to prevent, or at least reduce, overstocking problems. The hazards of overstocking might also be reduced by adjusting the amount of initial seed source to match the probability of obtaining prompt and abundant regeneration.

Foresters dealing with the problem of how to treat an area in order to establish a new stand for future harvest must consider a complex set of economic and biological factors; these circumstances seldom lead to an easy solution. There is certainly no panacea, no cut-and-dried procedure, which can be used with equal success everywhere and every time. Planting on prepared sites gives the best assurance of prompt regeneration of the desired species properly spaced for best future stand development; but this practice is limited by high site preparation and planting costs, plus the difficulties of obtaining planting stock or a suitable seed source at the right time. Natural regeneration will probably be our main source of new stands for many years. Studies such as those reported here can help to provide guidelines to be used in meeting our regeneration goals.

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Trends of natural regeneration in some northern Idaho western white pine stands under a variety of silvicultural systems and habitat types are described. On moist sites, characterized by a Thuja-Tsuga/Pachistima habitat type, any of the even-aged silvicultural systems resulted in adequate regeneration with desirable species diversity within 5 to 10 years following cutting. Drier sites, represented by the Abies grandis/Pachistima habitat type, were characterized by a prolonged regenerative period which may exceed 20 years regardless of silvicultural method used. Selection cutting on these sites tends to favor nearly pure grand fir reproduction.

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Headquarters for the Intermountain Forest and Range Experiment Station are in Ogden, Utah. Field Research Work Units are maintained in:

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